Architecture Transformation towards IoT Ecosystems

Enabling Data-Driven Development for Software-Defined Vehicles

Automotive Software Factory | September 22nd, 2021

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Architecture Transformation towards IoT Ecosystems

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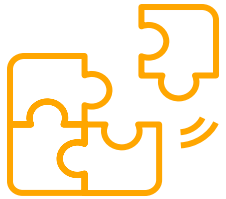
Vehicle Architecture Transformation

Vehicle Architecture Transformation
Changing Stakeholder Requirements

Addressing Stakeholder Needs

- Continuous Evolution (Digital Lifecycle)
- V2X & Cloud Integration
- Time2Market
- Integration of 3rd party SW
- Safety, Security & Privacy



Impact to Architecture

- Decoupling Hardware from Software & Services
- Compute Centralization
- Separate I/O from Compute
- Cloud / IoT Integration
- Platform & Interface Standardization

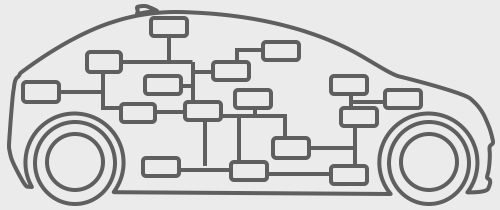
Drivers, Differentiators & Portfolio

- Driven by customer experience
- Software as main differentiator, innovation driver & asset
- Ability to provide solutions and integrate across IoT stack
- Scalable platforms and re-usable building blocks

Vehicle Architecture Transformation

Complexity & functional growth with current approach **reaching its limits**

Up2now

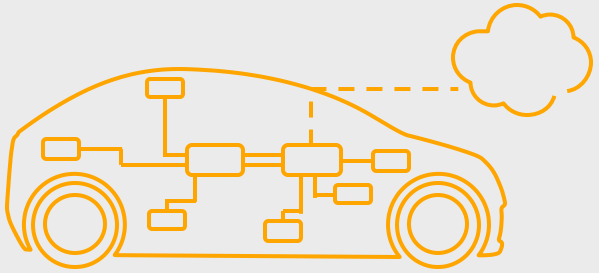


Patchwork architecture

- Up to ~100 ECUs, limited computing power
- Functionality isolated in ECUs
- Lots of wires
- Limited cloud-based functionality

User expectation: pleasure, safety and convenience

Going forward



Function-defined architecture

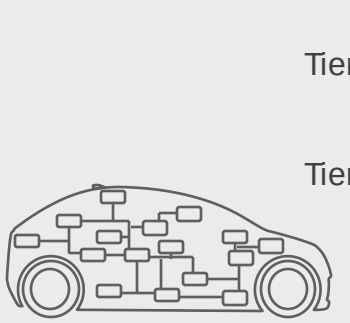
- Few High-Performance Computers and Zone Control, significant computing power
- Functions defined by SW (HW abstraction)
- ~50% reduction of wires
- Always connected

User expectation: smart IoT device

Vehicle Architecture Transformation

Trust-based **Collaboration & Partnership** Models

Hardware and function coupling – Software treated like hardware



Traditional car

Tier1 → OEM: Function development

Function development stops at SOP[1]

Tier2 → Tier1: Middleware, ECU integration

Middleware maintenance

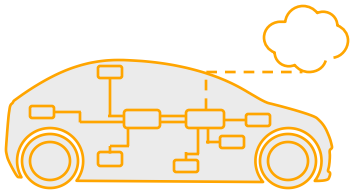
Tier1: Hardware development

Hardware production

Spare part delivery, garage maintenance services

SOP[1] EOP[2] EOL[3]

Software-defined vehicle needs a software platform partner throughout vehicle lifecycle



IoT car

Function development continues after SOP[1]

OEM: Function development

New functions and services

SW supplier: Middleware, ECU integration

Middleware adaption including security and safety support

Maintenance and lifetime security and safety support

HW supplier: Hardware development

Hardware production: Updates/changes possible

Spare part delivery, garage maintenance services

SOP[1] EOP[2] EOL[3]

[1] SOP: Start of production, [2] EOP: End of production, [3] EOL: End of life

Vehicle Architecture Transformation

From **domain** to **function & service** orientation

Up2now

Domain-oriented

Interior Cockpit / HMI	Body & Comfort	ADAS / AD	Safety / Motion	…
Appl.	Appl.	Appl.	Appl.	Appl.
SW / OS	SW / OS	SW / OS	SW / OS	SW / OS
HW	HW	HW	HW	HW
...	...	...	...	...

Going forward

Function-defined & Service-oriented

Scalable Compute Platform

- Functions / Applications
- Automotive SW Platform
- Continental HPC Platform

Cloud

- Digital Twin
- Predictive Maintenance
- Cloud Services
- Data Center

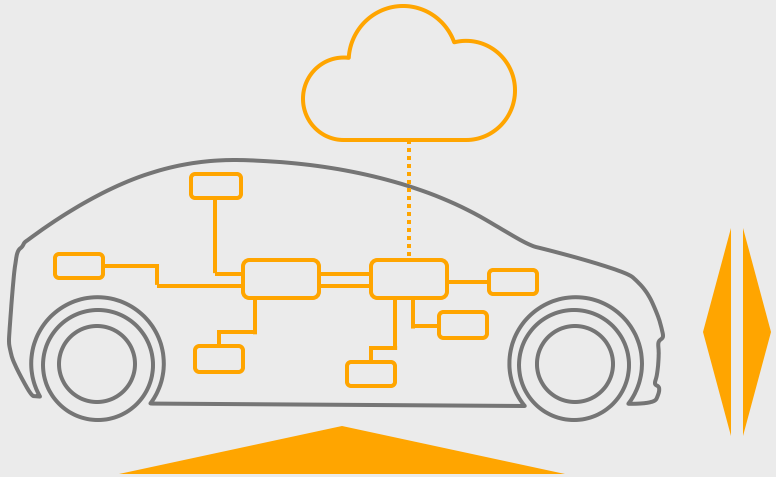
Vertical Integration
full solution/ stack that OEM can leverage

Horizontal Integration
synergies, reuse and maturity/quality

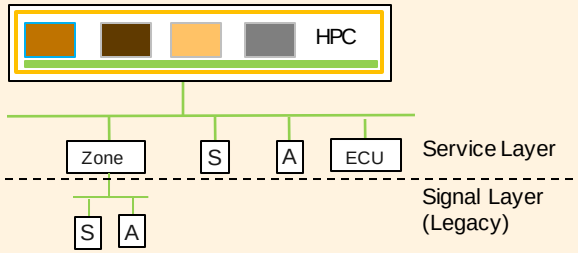
Software Defined Vehicle

Key elements of the Software Defined Vehicle

Continental Automotive Edge Framework – our full-stack IoT solution



Scalable Compute Platform



Vehicle Infrastructure

Note: Size of the boxes does not reflect the size or complexity of the software.

DevOps Workbench

Toolchain | CI / CD* | SW Distribution | Collaboration | Monitoring | Analytics

Scalable Compute Platform

Functions / Applications

Body | Cockpit | ADAS/ AD | Safety/ Motion

Automotive SW Platform

Platform Services

Middleware | Edge Enabler | Simulation & Validation Services

Core SW / OS

Continental HPC Platform

SoC | SoM | HPC

Cloud

Digital Twin | Predictive Maintenance

Cloud Services

Data Center

Cloud / On Premise

Vehicle Infrastructure

Sensors | Zones / ECUs | Actuators

* µP / SoC / SoM: Micro-Processor / System on Chip / Systemon Module ; CI / CD: Continuous Integration / Continuous Deployment

Key elements of the Software Defined Vehicle

Development Kits – enabling efficient product development

HPC / SCP

Automotive SW

Workbench

Cloud

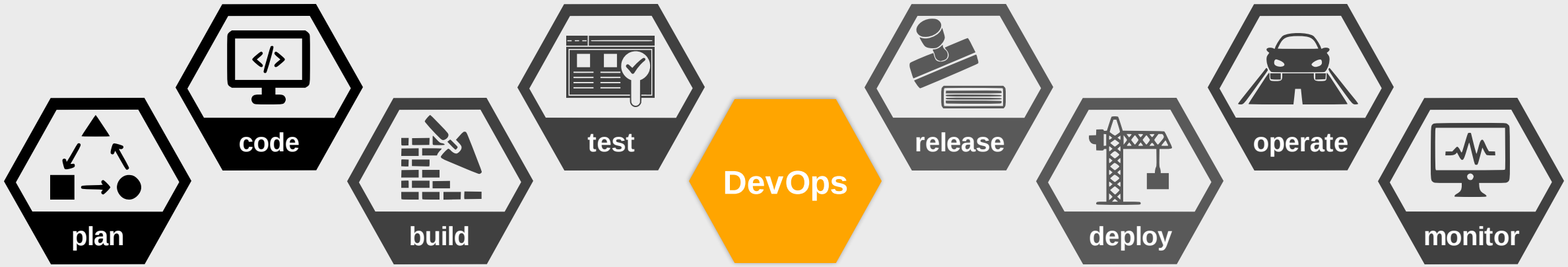
- **Harmonize** development and integration of distributed services & applications
- **Provide** a platform solution, clear interfaces & development environment
- **Enable** seamless development of service-oriented IoT ecosystem architectures

HPC = High-Performance Computer; SCP = Scalable Compute Platform; ZCU = Zone Control Unit

Key elements of the Software Defined Vehicles

Automotive DevOps in High Performance Computing

Continental Cooperation Portal | **Continental Software Factory** | **Continental HPC Platform(s)**



DEVELOPMENT

GitHub, JIRA, Confluence, doxygen, JFrog Artifactory, sonarqube, IBM DOORS, IBM Rhapsody, Plant UML

BUILD, TEST & INTEGRATION

Jenkins, python, ANSIBLE, EMU, MySQL, Gradle, Grafana, LINUX

DELIVERY

docker, VirtualBox, JFrog Artifactory, BLACKDUCK, Chocolatey

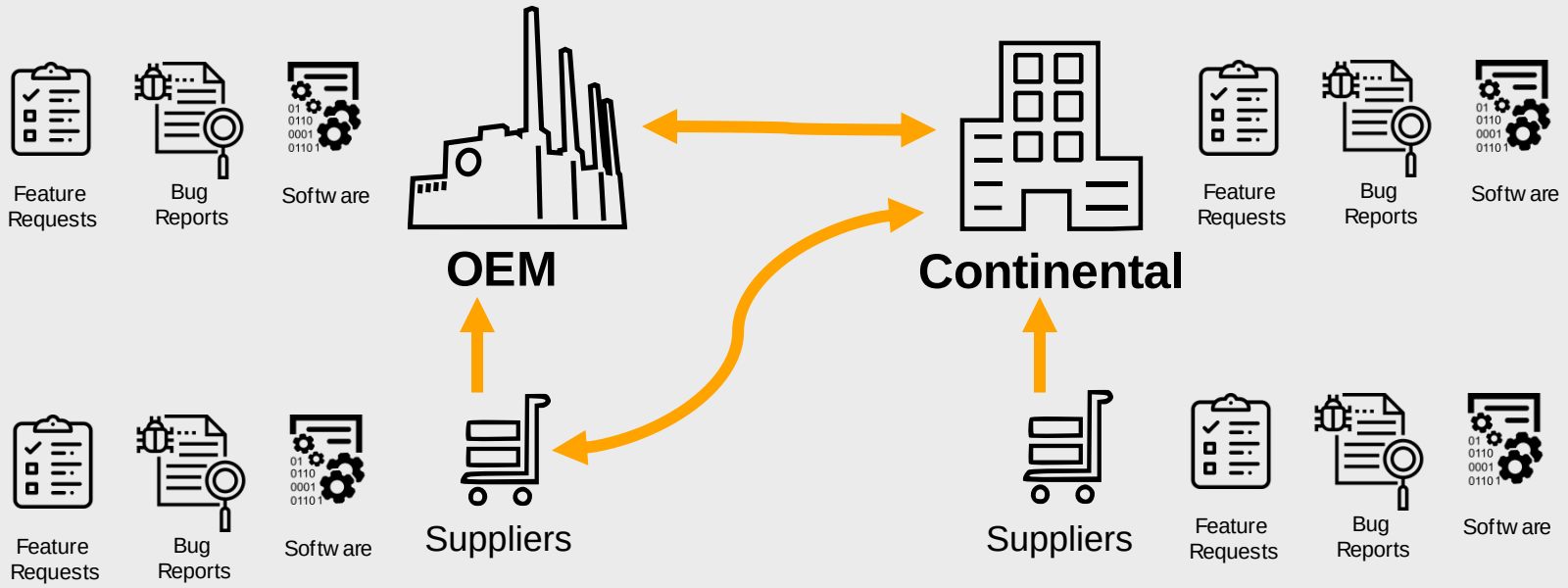
OPERATION

kubernetes, Azure, amazon web services, neo4j, TensorFlow, Terraform, mongoDB, kibana

Development for the Software Defined Vehicle

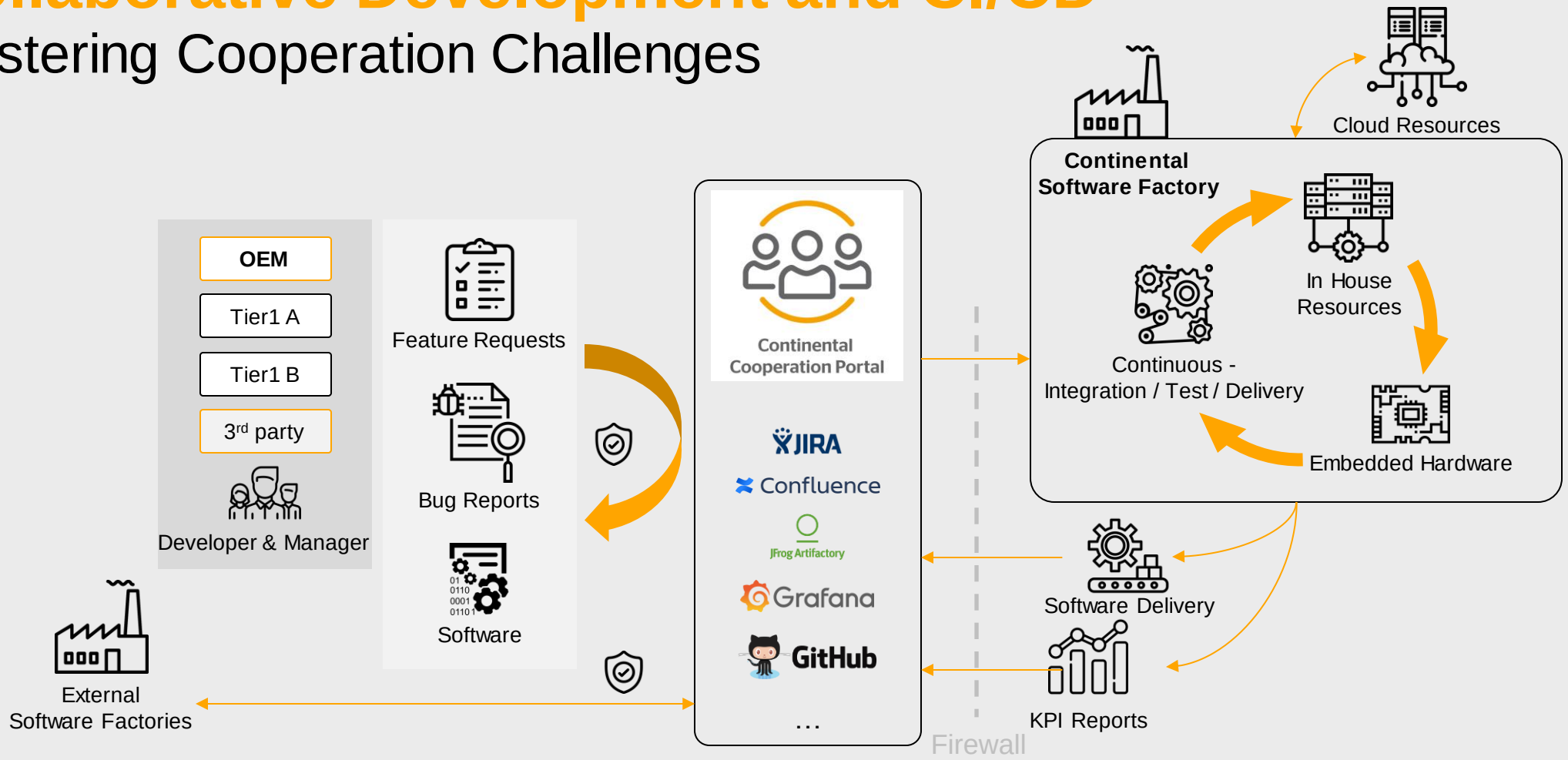
Collaborative Development and CI/CD

Cooperation Challenges



Collaborative Development and CI/CD

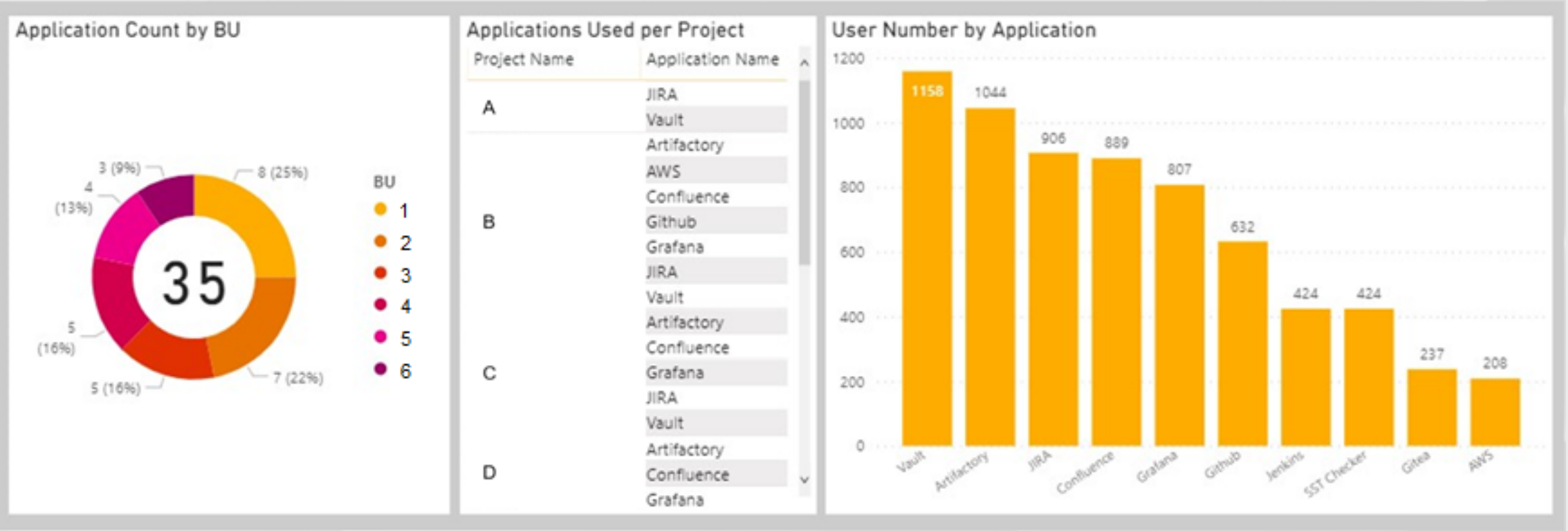
Mastering Cooperation Challenges



Continental Cooperation Portal

Statistics – Applications per Project

Source: CCP Power BI Monitoring, 08.06.2021



Currently, the primarily used **applications** in the **CCP** are Artifactory and Jira.

Data Driven Development

Data Driven Development during R&D

Use Case: Robustness validation of ADAS/AD functions

Drive vehicle, collect data

Embedded Target

2 Data acquisition

Analyze and upload data

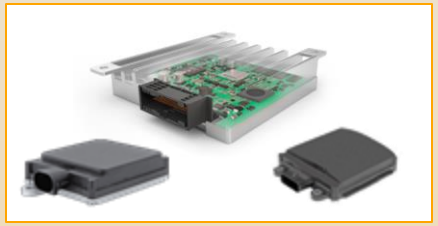
3

Data Ingest & Analytics

Datalake: Vehicle test data (> 1 mio km)

Deployment

1



Update Software

Optimize Algorithm

4

Model training

Simulation 5

Test optimized algorithm

Cloud Server

Validation

6

Validate with test data

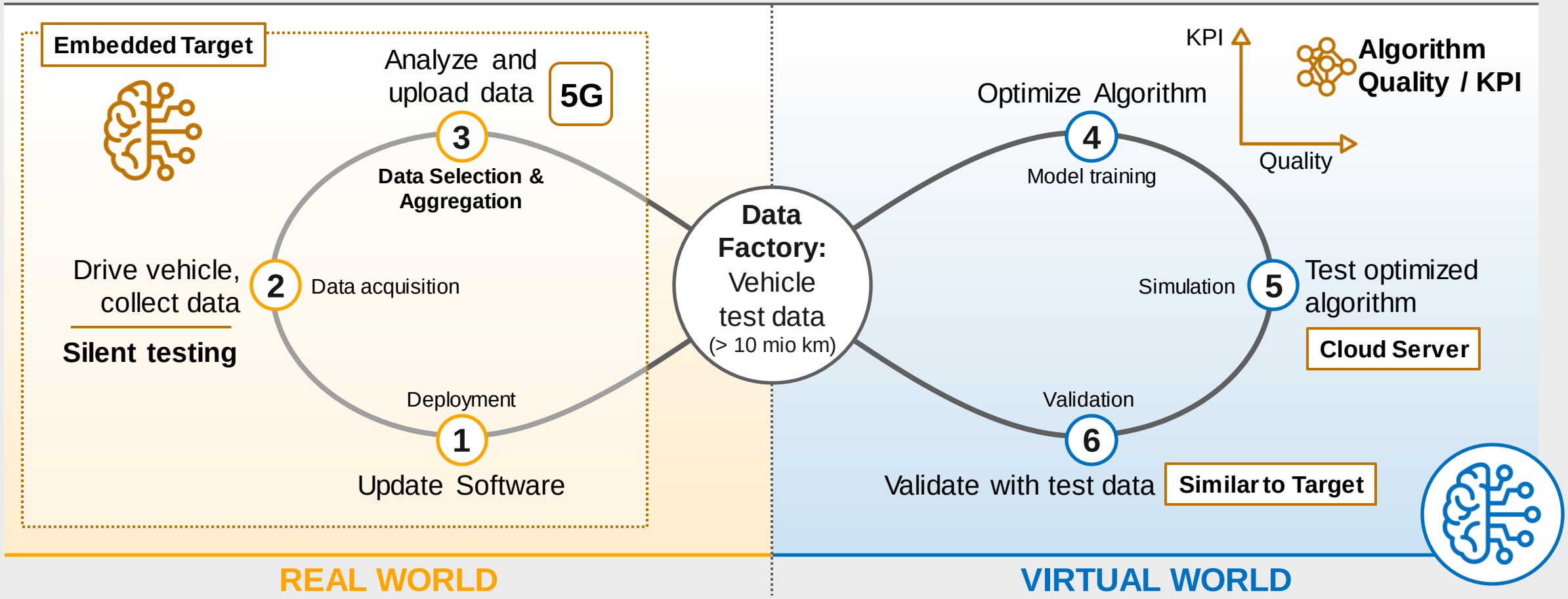
Similar to Target

Real world **Virtual world**

ADAS: Advanced Driver Assistance System, AD: Automated Driving

Data Driven Development

Evolution towards **Data Driven Ecosystem**



The Future in Motion

September 29, 2021